MP MASTER
MA23431

# PULSE GENERATING

# SYSTEM

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# INTRODUCTION

The Farnell Pulse Generating System is a versatile source of pulsed waveforms. A modular construction has been adopted in which each module has control of one parameter of the output waveform. In this way, pulse systems of a complex or simple nature can be assembled most economically.

The construction enables simple systems to be expanded at a later date into sophisticated arrangements by the addition of further standard modules. Alternatively, modules may be replaced by special purpose modules. Examples of these could include precision decade attenuator for precisions pulse height analysis; high voltage output unit; variable slope output unit and very fast risetime unit.

The mechanical construction is such that the modules are inserted through the base of the frame.

Unclipping of the case cover gives access to the rear mounted power and patching leads, plugs and sockets.

The case size has been designed to allow 19" (483mm.) rack mounting if required, and will accommodate a power supply and eight modules.

The power supply module PS/A has a width of 2.4" (60mm.), whilst all other modules are 1.8" (45mm.) wide.

The overall dimensions of the frame are as follows; width 430mm (16.9"); height 177mm. (7"); depth 280mm (11").

The basic modules available are as follows:-

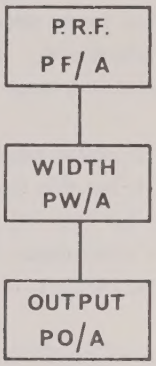
P.R.F. Generator
TRIGGER Unit
PULSE DELAY
PULSE WIDTH
OUTPUT Unit
POWER SUPPLY

The power supply unit will operate from 110V or 240V 50 Hz mains supplies, giving + 5V, -5V, + 25V and - 25V stabilised rails.

The output module has an output impedance of 50Ω and will supply a 10V pulse into 50Ω. Progressively larger amplitude pulses are available into higher load impedances, up to a maximum of 20V into an open circuit.

In the case of a simple arrangement, the unit could comprise:-

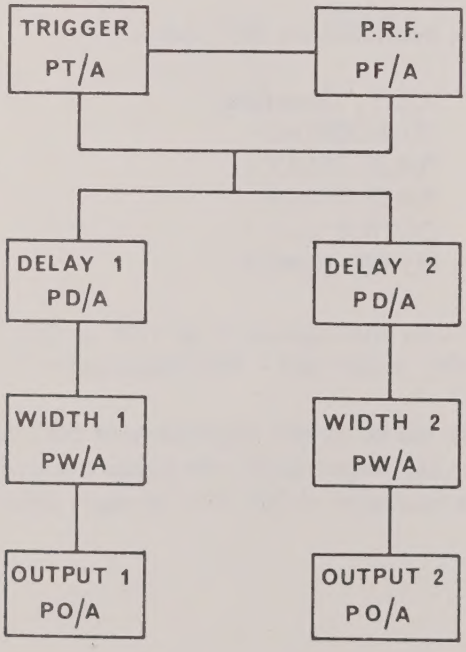
POWER SUPPLY
P.R.F. Generator
PULSE WIDTH
OUTPUT Unit




A more complex system utilising the full rack could comprise:-

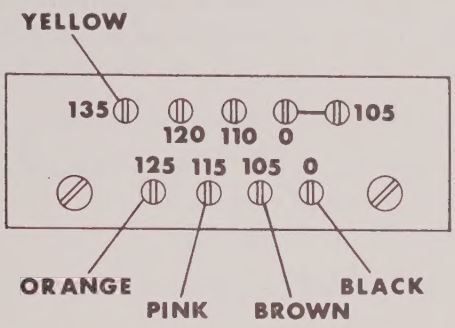
POWER SUPPLY
TRIGGER Unit
P.R.F. Generator
2 off PULSE DELAY
2 off PULSE WIDTH
2 off OUTPUT Unit

With this arrangement wired as below, a double pulse generator giving two pulses of independent width, delay, output level and polarity can be obtained:-



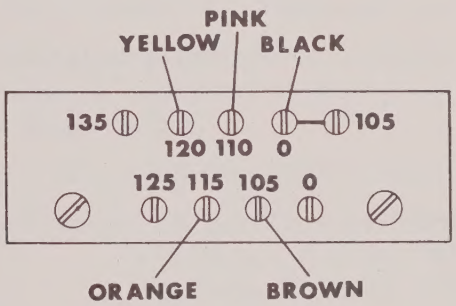
## 240V. OPERATION

The instrument is set for operation on the 240V range (210V - 240V) when despatched.




## 110V. OPERATION

For 110V operation, (105V - 120V), the voltage selector wires must be reconnected to the adjacent pins on the transformer tagboard inside the power supply unit as shown.




## REMOVAL OF MODULES

Ensure that the POWER SUPPLY is switched OFF.

The modules are removed from the base of the unit. To remove a module, the cover should be unclipped and the power and patching leads disconnected at the rear of the unit. The two screws securing the module frame to the lower rear bar and the upper front bar of the case should be removed. The module can then be disengaged from position by pressure on the base, directed towards the rear of the unit.

The module can then be pulled clear.

## REPLACEMENT OF MODULES

The modules can be replaced by insertion through the base of the instrument

CAUTION - Care should be taken when plugging the module supply leads into the supply sockets, to adhere to the colour code. Each lead is brought out adjacent to the correct socket.

# SPECIFICATIONS

1. P.R.F. Module - PF/A

Coarse frequency control: 'Range' switch selects 7 frequency ranges - 1Hz, 10Hz, 100Hz, 1KHz, 10KHz, 100KHz, and 1MHz.

Fine frequency control: 'Multiplier' potentiometer, calibrated 1 to 10 enabling the P.R.F. to be adjusted up to a decade above the setting of the 'Range' switch.

Calibration accuracy: ± 10% of full scale of fine control on all ranges.

Max. temperature coefficient: + 1% per °C on the 1Hz range,
∓ 0.5% per °C on the 10Hz & 100Hz ranges,
∓ 0.2% per °C on all other ranges.

P.R.F. Jitter: 0.2% of maximum setting of P.R.F. multiplier control.

2. Pulse Delay Module - PD/A

The 'Function' switch may be set to give three modes of operation - 'Zero' delay, 'Single' delayed pulse, or 'Double' pulse output giving both an undelayed and a delayed pulse output.

Coarse delay control: 'Range' switch selects 7 delay ranges, 0.1μS, 1μS, 10μS, 100μS, 1mS, 10mS, and 100mS.

Fine delay control: 'Multiplier' potentiometer, calibrated 1 to 10 enabling the delay to be adjusted up to a decade above the setting of the 'Range' switch.

Calibration accuracy: ± 10% of full scale of fine control on all ranges.

Max. temperature coefficient: + 1% per °C on the 100mS range
∓ 0.5% per °C on the 1mS & 10mS ranges,
∓ 0.2% per °C on all other ranges.

Delay Jitter: 0.2% of maximum setting of delay fine control.

Sync. pulse output: An undelayed sync. pulse is available at the BNC socket on the front of this module.

Sync. pulse characteristics: A positive polarity pulse of 5V amplitude from a source resistance of less than 500Ω . The pulse width is approximately 80nS, and the rise-time approximately 20nS.

3. Pulse Width Module - PW/A

Coarse width control: 'Range' switch selects 7 width ranges - 0.1μS, 1μS, 10μS, 100μS, 1mS, 10mS and 100mS.

Fine width control: 'Multiplier' potentiometer, calibrated 1 to 10 enabling pulse width to be adjusted up to a decade above the setting of the 'Range' switch.

Calibration accuracy: ± 10% of full scale of fine control on all ranges.

Max. temperature coefficient: + 1% per °C on 100mS range,
∓ 0.5% per °C on 1mS range,
∓ 0.2% per °C on all other ranges.

Width jitter: 0.2% of maximum setting of time width control.

The outputs from up to three width units may be connected in parallel, also one width unit may drive up to four pulse output modules (either P0/A or P0/V)


Continued/....

4. Output Module - PO/A

Positive or negative pulses referred to OV. selected by switch
maximum d.c. offset: 25mV

Maximum risetime: 10nS ) Output set to 10 volts feeding into 50Ω
Maximum fall time: 10nS )

Output impedance: 50Ω ± 10%
Output level:-

Maximum output level into open circuit: 20V
Output continuously variable over 10 dB range by potentiometer.

| Switch attenuator: | | | | |
|---|---|---|---|---|
| | - 0dB | - | 3 - 10V | into 50Ω |
| | - 10dB | - | 1 - 3.3V | |
| | - 20dB | - | 300mV - 1V | |
| | - 30dB | - | 100mV - 330mV | |
| | - 40dB | - | 30mV - 100mV | |

Attenuator accuracy ± 5%

Perturbation: 10% total excursion on full amplitude of output level.

Overshoot and Ringing:
10% on 0dB - 10dB and -20dB ranges
20% on -30dB and -40dB ranges

Measured at full output on each attenuator setting into 50Ω load.

Maximum duty cycle: 1Hz - 2MHz: 90%
2MHz - 10MHz: 70%

The output module will withstand a short-circuit for 1 minute at any output condition.

Output Socket: 50Ω B.N.C.

5. Trigger Module - PT/A

A 'mode' switch enables the pulse generator to be operated in three distinct modes:-

a). INTERNAL This allows the P.R.F. generator to free run
b). BURST This allows the P.R.F. generator to be turned on and off by inputs to the trigger unit.
c). EXTERNAL This enables inputs to the trigger unit to trigger output pulses directly irrespective of input wave shape or polarity.

| | | |
|---|---|---|
| External Trigger: | Minimum triggering amplitude: | ± 1V to 1MHz |
| | | ± 1.5V to 10MHz |
| | Maximum permissible input level: | ± 30V |
| Burst: | Maximum triggering rate: | 10 MHz |
| | Maximum operating rate: | 1MHz |
| | Minimum operating amplitude: | + 1V |
| | Input connection: | BNC socket. |
| | Input impedance: | 2K Ω// 47 pF. |


Continued/....

6. Power Supply Module - PS/A

| | |
|---|---|
| Mains Input tappings: | 210V, 220V, 230V, 240V. selected by mains selector. |
| Alternatively: | 105V, 110V, 115V, 120V selected by mains selector. |
| Mains frequency: | 40 - 60Hz |
| Mains Power Consumption: | 60W maximum |

Stabilised rails are available as below to run up to 8 modules including two output modules.

| | | |
|---|---|---|
| Yellow: | +25V ) | 0.75A total (0.75A from one rail or 0.37A from both rails) |
| White: | -25V ) | |
| Red: | +5V | 250mA |
| Blue: | -5V | 250mA |
| Black: | 0V | |

Overall temperature stability, 15°C to 35°C: 0.2V

| | |
|---|---|
| Regulation: | 0.2V |
| Ripple: | 20mV peak - peak |

7. Variable Slope Output Module - PO/V

The rise and fall of pulse can be set within the following ranges:

1.1nS/V - 11nS/V, 11nS/V - 0.1µS/V, .11µS/V - 11µS/V,
1.1µS/V - 11µS/V, 11µS/V - .11mS/V, .11mS/V - 1.1mS/V,
1.1mS/V - 11mS/V.

Variable controls enable a decade adjustment of the slopes, the rise and fall are independently adjustable over this range.

Maximum peak to peak excursion of the output pulse of this module is +20V to -20V into open circuit, this is set by level controls.

| | |
|---|---|
| Output impedance 50Ω | ±10% |
| Perturbation: | 10% total |
| Overshoot and ringing: | 10% of maximum amplitude. |

The excursion of the pulse (level) may be set by means of two controls, determining the positive and negative levels respectively. The levels can be set between -4V to +20V into open circuit (+ve level) and +4V to -20V (-ve level). A mark is printed on the panel to enable the controls to be set at 0V ± 0.5V.
A ' ÷ 10 switch' reduces the output pulse to one tenth its unattenuated amplitude. An 'invert switch' enables the pulse to be inverted.

NOTE that on 'invert' the 'rise' control varies the trailing edge and the 'fall' controls varies the leading edge. Also it should be noted that the pulse width is defined as the period between the commencement of the pulse to the point where the trailing edge commences.

8. General Specifications

| | | |
|---|---|---|
| Operating temperature range | 0 - 50°C | |
| Duty cycle: | 1 Hz to 2MHz: | 90% |
| | 2 MHz to 10MHz: | 70% |

Overall Dimensions:

| | |
|---|---|
| Width: | 16.9" (430 mm). |
| Height: | 7" (177 mm). |
| Depth: | 11" (280 mm). |

Excluding feet and handles.

An adaptor is available to enable the pulse generator to fit in a 19" (477 mm) rack.

# POWER SUPPLY

PS/A

The power supply module (PS/A) provides four stabilised supply rails to operate up to two output modules and six other modules. The rails are regulated against ± 10% mains voltage variation and load variations encountered in the pulse generator.

## SPECIFICATION

| | |
|---|---|
| Input voltages | 210 to 240V 50 c/s<br>105 to 120V 60 c/s |
| Output voltages | +5V at 0.25A<br>-5V at 0.25A<br>+25V) at 0.75A total either 0.75A<br>-25V) from one rail or 0.37A<br>from both ± rails. |
| Ripple | 10mV pk - pk |

## CIRCUIT DESCRIPTION

Four similar stabilised power supplies of conventional design are used to provide the required supply rails from four full-wave rectifying and smoothing circuits: D1 to D8 and C7 to C10.

### +25V rail

The voltage appearing across R4, which is a fraction of the voltage across C2, is compared with the reference voltage across Z2, by the long-tailed pair VT2 and 3; any error between the two is amplified and applied to the series regulator VT13 via VT1 in such a sense as to correct the original error. The voltage across C2 is thus maintained at a multiple of the reference voltage determined by R6 and T1 and R4. The regulated output voltage may be adjusted by T1.

As the reference zener diode and control amplifier are fed from the +25V stabilised line, it is necessary to include a starting zener diode across the series regulator. On switching on the module, the voltage across C2 is zero and hence the control amplifier has no supply and is thus inoperative. In this condition the voltage across VT13 is sufficient to cause Z1 to conduct so that current is diverted to the control amplifier to enable it to function. Once the amplifier and regulator are operating the voltage across the series regulator VT13 is insufficient to maintain Z1 conducting and thus it plays no further part.

### -25V rail

This is similar to the +25V rail supply except that the regulated supply is taken from the collector of the series regulator VT15. T3 adjusts the regulated output voltage.

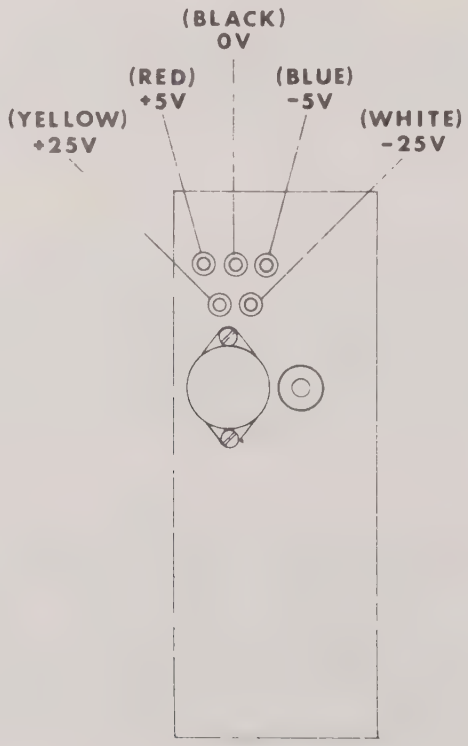
+5V and -5V rails.

These supplies are also similar to 25V rails except that the reference voltages are derived from the 25V rails by potential dividers R7 and R8, and R20 and R21 for the +5V and -5V respectively. T2 adjusts the +5V regulated output voltage and T4 adjusts the -5V regulated output voltage.

The power supply is protected by fuses located on the front panel, the 25V supplies are fitted with 1A fuses and the 5V supplies have 0.5A fuses. A 0.5A mains supply fuse is fitted. Should any of the fuses become open circuit, the instrument will cease to operate.

110V OPERATION

The transformer is normally connected for 240V operation. To operate from 110V mains supply, it is necessary to change the transformer connections inside the module. Wiring instructions are given on page 3 of the INTRODUCTION.



# POWER SUPPLY

PS/A

| | | | | |
|---|---|---|---|---|
| R1 | Resistor | 390Ω | 0.5 Watt | 5% |
| R2 | " | 150Ω | " | " |
| R3 | " | 3.9KΩ | " | " |
| R4 | " | 1 KΩ | " | " |
| R5 | " | 1 KΩ | " | " |
| R6 | " | 2.7KΩ | " | " |
| R7 | " | 2.2KΩ | " | " |
| R8 | " | 220Ω | " | " |
| R9 | " | 470Ω | " | " |
| R10 | " | 1.2KΩ | " | " |
| R11 | " | 150Ω | " | " |
| R12 | " | 390Ω | " | " |
| R13 | " | 1 KΩ | " | " |
| R14 | " | 150Ω | " | " |
| R15 | " | 390Ω | " | " |
| R16 | " | 3.9KΩ | " | " |
| R17 | " | 1 KΩ | " | " |
| R18 | " | 1 KΩ | " | " |
| R19 | " | 2.7 KΩ | " | " |
| R20 | " | 220Ω | " | " |
| R21 | " | 2.2KΩ | " | " |
| R22 | " | 150Ω | " | " |
| R23 | " | 390Ω | " | " |
| R24 | " | 470Ω | " | " |
| R25 | " | 1KΩ | " | " |
| R26 | " | 1.2KΩ | " | " |
| R27 | " | 1 MΩ | " | " |
| R28 | " | 1 MΩ | " | " |
| R29 | " | 1 MΩ | " | " |
| R30 | " | 1 MΩ | " | " |

| | | | |
|---|---|---|---|
| C1 | Capacitor | 0.1μF | 160v |
| C2 | " | 100μF | 25v |
| C3 | " | 200μF | 10v |
| C4 | " | 0.1μF | 160v |
| C5 | " | 100μF | 25v |
| C6 | " | 200μF | 10v |
| C7 | " | 2000μF | 50v |
| C8 | " | 2000μF | 16v |
| C9 | " | 2000μF | 50v |
| C10 | " | 2000μF | 16v |
| C11 | " | 0.01μF | 160v |
| C12 | " | 0.01μF | 160v |
| C13 | " | 0.01μF | 160v |
| C14 | " | 0.01μF | 160v |

| | | | |
|---|---|---|---|
| T1 | Potentiometer | 2.2KΩ | |
| T2 | " | 1 KΩ | |
| T3 | " | 2.2KΩ | |
| T4 | " | 1 KΩ | |

| | | | |
|---|---|---|---|
| VT1 | Transistor | 2N3702 | T.I. |
| VT2 | " | BC182L | T.I. |
| VT3 | " | BC182L | T.I. |
| VT4 | " | BC182L | T.I. |
| VT5 | " | BC182L | T.I. |
| VT6 | " | 2N3702 | T.I. |
| VT7 | " | BC182L | T.I. |
| VT8 | " | 2N3702 | T.I. |
| VT9 | " | 2N3702 | T.I. |
| VT10 | " | BC182L | T.I. |
| VT11 | " | 2N3702 | T.I. |
| VT12 | " | 2N3702 | T.I. |
| VT13 | " | 2N3055 | R.C.A. |
| VT14 | " | 2N3055 | R.C.A. |
| VT15 | " | 2N3055 | R.C.A. |
| VT16 | " | 2N3055 | R.C.A. |

| | | | |
|---|---|---|---|
| D1 | Diode | BYX36/300 | Mullard |
| D2 | " | " | " |
| D3 | " | " | " |
| D4 | " | " | " |
| D5 | " | " | " |
| D6 | " | " | " |
| D7 | " | " | " |
| D8 | " | " | " |

| | | | |
|---|---|---|---|
| Z1 | Zener Diode | MZ27T5 | I.R.C. |
| Z2 | " | HS2051 | Emihus |
| Z3 | " | MZ27T5 | I.R.C. |
| Z4 | " | HS2051 | Emihus |

# TRIGGER UNIT

PT/A

The trigger unit controls the mode of operation of the pulse generating system, enabling the output pulses to be triggered from the P.R.F. generator directly, or via a gate which may be opened by an input applied to the trigger unit, or this input may be used to directly trigger output pulses. Trigger inputs of either polarity may be applied to this unit.

## SPECIFICATION

EXTERNAL

| | | |
|---|---|---|
| Maximum triggering rate | | - 10MHz |
| Minimum triggering amplitude on '+' | | - 1V peak to 1 MHz |
| | | + 1.5V peak to 10 MHz |
| | on '-' | - - 1V peak to 1 MHz |
| | | - 1.5V peak to 10 MHz |

BURST

| | |
|---|---|
| Maximum triggering rate | - 1MHz |
| Minimum triggering amplitude | - + 1V |

INPUT IMPEDANCE - 2KΩ/47 pF

## DESCRIPTION AND CONTROLS

(1) Trigger MODE switch determines mode of operation. On INTERNAL, the P.R.F. generator triggers the output pulses. On EXTERNAL, inputs to the trigger unit trigger the output pulses. On BURST, inputs to the trigger unit gate the output from the P.R.F. generator to trigger the output pulses.

(2) The MANUAL push button S3, which only functions when polarity switch S1 is at '+', gives one-shot pulses when the mode switch is set to EXTERNAL, or can be used to manually gate bursts when the mode switch is set to BURST. The push button is ineffective with the mode switch on INTERNAL, or when the polarity switch is set to '-'.

(3) The EXT. CONTACT sockets provide the facility to use external contact closure - e.g. camera shutter contacts - to trigger pulses or bursts in the same manner as the MANUAL push-button.

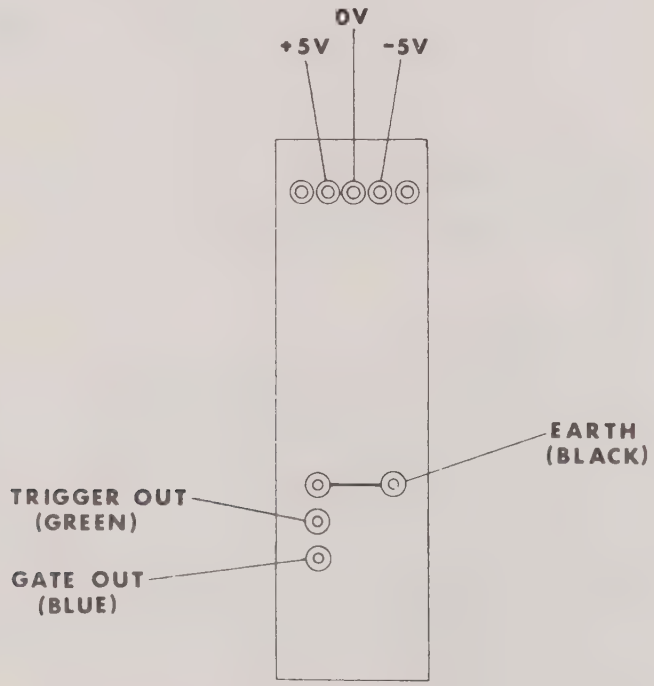
(4) The TRIGGER POLARITY switch determines which polarity of an input signal will trigger an output pulse. On '+', positive going signals of + 1V, up to a frequency of 1 MHz, will cause an output trigger. On '-', negative going signals of 1V, up to a frequency of 1 MHz, will cause an output trigger.

(5) The INPUT socket is a female BNC connector, and accepts trigger inputs as listed above. Maximum inputs should be less than 50V peak, and less than 25V D.C.

## CIRCUIT DESCRIPTION

The input signal is fed to a long-tailed pair, transistors VT1 and VT2, the input base of which is biassed off or on for either +ve or -ve inputs respectively. The output from the long-tail pair is taken from the collector of VT1 for +ve inputs and from the collector of VT2 for -ve inputs. This is fed to a Schmitt trigger circuit comprising transistors VT3 and VT4. The output from this is fed directly to VT6 which provides the +4v gating signal for feeding to the P.R.F. generator unit when using BURST operation. The signal from the Schmitt trigger is also differentiated and fed to the base of VT5 which in turn provides +4v output pulses via an emitter follower VT7. These pulses are fed to the delay unit for direct triggering of output pulses, when using EXTERNAL operation.

The module operates from +5v and -5v supplied by the power supply module PS/A. The current from these lines is approximately 25mA.



| | | | | |
|---|---|---|---|---|
| R1 | Resistor | 2.2KΩ | 5% | 0.5 watt |
| R2 | " | 2.2KΩ | " | " |
| R3 | " | 22KΩ | " | " |
| R4 | " | 22KΩ | " | " |
| R5 | " | 2.2KΩ | " | " |
| R6 | " | 2.2KΩ | " | " |
| R7 | " | 2.7KΩ | " | " |
| R8 | " | 1.5KΩ | " | " |
| R9 | " | 150Ω | " | " |
| R10 | " | 1KΩ | " | " |
| R11 | " | 680Ω | " | " |
| R12 | " | 2.2KΩ | " | " |
| R13 | " | 330Ω | " | " |
| R14 | " | 680Ω | " | " |
| R15 | " | 10KΩ | " | " |
| R16 | " | 470Ω | " | " |
| R17 | " | 390Ω | " | " |
| R18 | " | 390Ω | " | " |
| R19 | " | 470Ω | " | " |
| R20 | " | 470Ω | | |
| R21 | " | 47Ω | " | " |
| R22 | " | 3.3KΩ | " | " |
| R23 | " | 4.7KΩ | " | " |
| R24 | " | 150KΩ | " | " |
| R25 | " | 150KΩ | " | " |
| R26 | " | 47Ω | " | " |

| | | | |
|---|---|---|---|
| L1 | Choke | 7μH | |
| L2 | " | 7μH | |
| L3 | " | 3.3μH | Painton |

| | | | | |
|---|---|---|---|---|
| C1 | Capacitor | 0.1μF | | 160v |
| C2 | " | 0.1μF | | 160v |
| C3 | " | 100 pf. | 20% | 400v |
| C4 | " | 100 pf. | 20% | 400v |
| C5 | " | 15 pf. | 10% | 500v |
| C6 | " | 47 pf. | 10% | 500v |
| C7 | " | 15 pf. | 10% | 500v |
| C8 | " | 25μF | | 6.4v |
| C9 | " | 25μF | | 6.4v |
| C10 | " | 2.2μF | | 16v |

| | | | |
|---|---|---|---|
| VT1 | Transitor | TIS48 | T1 |
| VT2 | " | TIS48 | T1 |
| VT3 | " | TIS48 | T1 |
| VT4 | " | TIS48 | T1 |
| VT5 | " | BSX29 | SGS-F |
| VT6 | " | BSX29 | SGS-F |
| VT7 | " | TIS48 | T1 |

| | | | |
|---|---|---|---|
| D1 | Diode | IN914 | T1 |
| D2 | " | IN914 | T1 |
| D3 | " | IN914 | T1 |

# P.R.F. GENERATOR

PF/A

The P.R.F. Generator normally determines the repetition frequency available from the instrument, except in the case of external triggering.

The frequency is covered in seven ranges:-

| | | |
|---|---|---|
| 1Hz | - | 10Hz |
| 10Hz | - | 100Hz |
| 100Hz | - | 1KHz |
| 1KHz | - | 10KHz |
| 10KHz | - | 100KHz |
| 100KHz | - | 1MHz |
| 1MHz | - | 10MHz |

The level of the output square wave is from -0.5v to 4.0v. Facility is available to switch the oscillator on by the application of a +4v signal and in this way, a burst of pulses for the duration of the applied voltage can be obtained.

## CIRCUIT DESCRIPTION

A conventional cross coupled astable multivibrator is used as the basic oscillator. The multivibrator comprises transistors VT2 and VT8 coupled to emitter followers VT3 and VT9, which enable a high repetition frequency to be achieved. The output waveform is taken from VT9 emitter.

The frequency range is determined by the timing capacitors C1 and C2 to C13 and C14 which are switched into circuit by the range control on the front panel.

Transistors VT4 and VT5 are the current feeds to the timing capacitors. The emitter resistors R8 and R11 are returned to a common voltage point and the variation of this voltage controls the relaxation period of the multivibrator. By this means, a linear voltage versus frequency characteristic is obtained. The limits of the variable frequency control P1 are set by the trimmer potentiometer to cover a decade on each range. Separate adjustment is available at each end of all ranges.

In normal operation, transistor VT1 is bottomed and can be neglected, but, the oscillator may be switched off by the application of 0V to the base of VT1 which is then cut off. Base resistor R3 is normally returned to +5V. The application of a square wave to R3 therefore, will give bursts of square waves at the output of the module.

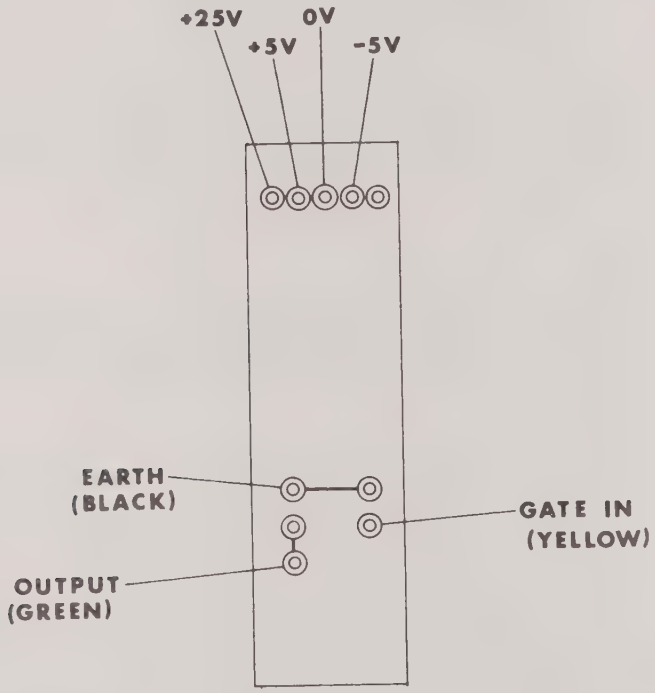
Transistor VT6 is coupled to both halves of the multivibrator by R7 and R11 and senses if both VT2 and VT8 should become bottomed due to the charging current being set at too high a value. Should this condition arise, VT6 cuts off and the multivibrator is restarted.

The output square wave is taken from the emitter of VT9 via resistor R17 which protects VT9 against any accidental momentary shorting of the output.

The signal level at the output is 4.5V from -0.5V to +4.0V.

The unit operates from +5v, -5v and +25v provided by the power supply module PS/A.
The current from these lines is as follows:

+25V····· 37mA
+5V····· 37mA
-5V····· 28mA



| | | | | |
|---|---|---|---|---|
| R1 | Resistor | 47Ω | 0.5 watt | 5% |
| R2 | " | 470Ω | " | " |
| R3 | " | 1KΩ | " | " |
| R4 | " | 470Ω | " | " |
| R6 | " | 220Ω | " | " |
| R7 | " | 3.3KΩ | " | " |
| R8 | " | 1.2KΩ | " | " |
| R9 | " | 2.7KΩ | " | " |
| R10 | " | 680Ω | " | " |
| R11 | " | 1.2KΩ | " | " |
| R12 | " | 3.3KΩ | " | " |
| R13 | " | 220Ω | " | " |
| R14 | " | 470Ω | " | " |
| R15 | " | 470Ω | " | " |
| R16 | " | 47Ω | " | " |
| R17 | " | 47Ω | " | " |
| R18 | " | 4.7KΩ | " | " |

| | | | | |
|---|---|---|---|---|
| C1 | Capacitor | 47pf | 20% | 400V |
| C2 | " | 47pf | 20% | 400V |
| C3 | " | 1000pf | 5% | 400V |
| C4 | " | 1000pf | 5% | 400V |
| C5 | " | 0.01pF | 5% | 160V |
| C6 | " | 0.01μF | 5% | 160V |
| C7 | " | 0.1μF | 5% | 160V |
| C8 | " | 0.1μF | 5% | 160V |
| C9 | " | 1μF | 20% | 63V |
| C10 | " | 1uF | 20% | 63V |
| C11 | " | 10μF | | 16V |
| C12 | " | 10μF | | 16V |
| C13 | " | 100μF | | 6.4V |
| C14 | " | 100μF | | 6.4V |
| C15 | " | 100μF | | 6.4V |
| C16 | " | 100μF | | 6.4V |

| | | | |
|---|---|---|---|
| T1 | Potentiometer | 2.2KΩ | |
| T2 | " | 2.2KΩ | |
| T3 | " | 2.2KΩ | |
| T4 | " | 2.2KΩ | |
| T5 | " | 2.2KΩ | |
| T6 | " | 2.2KΩ | |
| T7 | " | 2.2KΩ | |
| T8 | " | 220Ω | |
| T9 | " | 220Ω | |
| T10 | " | 220Ω | |
| T11 | " | 220Ω | |
| T12 | " | 220Ω | |
| T13 | " | 220Ω | |
| T14 | " | 220Ω | |

| | | | |
|---|---|---|---|
| VT1 | Transistor | TIS48 | T.1. |
| VT2 | " | TIS48 | T.1. |
| VT3 | " | TIS48 | T.1. |
| VT4 | " | 2N3702 | T.1. |
| VT5 | " | 2N3702 | T.1. |
| VT6 | " | BC182L | T.1. |
| VT7 | " | BC182L | T.1. |
| VT8 | " | TIS48 | T.1. |
| VT9 | " | TIS48 | T.1. |
| VT10 | " | BC182L | T.1. |

| | | | |
|---|---|---|---|
| D1 | Diode | IN914 | T.1. |
| D2 | " | IN914 | T.1. |
| D3 | " | IN914 | T.1. |

P1 Potentiometer 1 KΩ Linear

The pulse delay unit determines the time delay between the input trigger and the pulse output.

On double pulse operation, the delay time governs the separation between the occurrence of the two pulses. The delay is adjustable from 0.1 μS to 1.0 S. in seven decade ranges.

| | | |
|---|---|---|
| 0.1 μS. | - | 1 μS. |
| 1.0 μS. | - | 10 μS. |
| 10 μS. | - | 100 μS. |
| 100 μS. | - | 1 mS. |
| 1 mS. | - | 10 mS. |
| 10 mS. | - | 100 mS. |
| 100 mS. | - | 1 S. |

The output from the unit is a positive trigger pulse to the pulse width module. The delay can be switched out on the function switch, in which case, the input pulse is passed through the unit with minimum delay. A +4V pulse output is available at the coaxial socket on the front panel for synchronization purposes.

In double pulse operation, the input trigger and the delay trigger are combined to give the two trigger pulses, separated by the pulse delay.

## CIRCUIT DESCRIPTION

A conventional monostable multivibrator is used as the basic delay element. The multivibrator comprises transistors VT4 and VT6.

The delay range is determined by the timing capacitors C1 to C7 which are switched into circuit by the front panel range switch. The continuous control RV1 allows adjustment of the delay time over a decade range. The circuit is designed such that the delay varies in a linear manner with control rotation.

The input signal to the delay unit, from the trigger or P.R.F. module, feeds via R1 into the pulse forming stage VT1 and VT3. A positive pulse is taken to the coaxial socket on the front panel via VT2, for synchronization purposes. The output synchronization pulse is capacitively coupled from the emitter follower VT2 and will deliver a 4V pulse into 220 Ω

The trigger pulse at VT3 emitter turns on the monostable multivibrator for the set delay time. The negative pulse at VT4 collector, passes via switch VT8 to the trigger forming stage VT12 and VT13 which gives a pulse output of 50 nS duration at the trailing positive going edge of the delay pulse.

The switch VT8 is closed by applying +5V to R17 and opened by -5V.

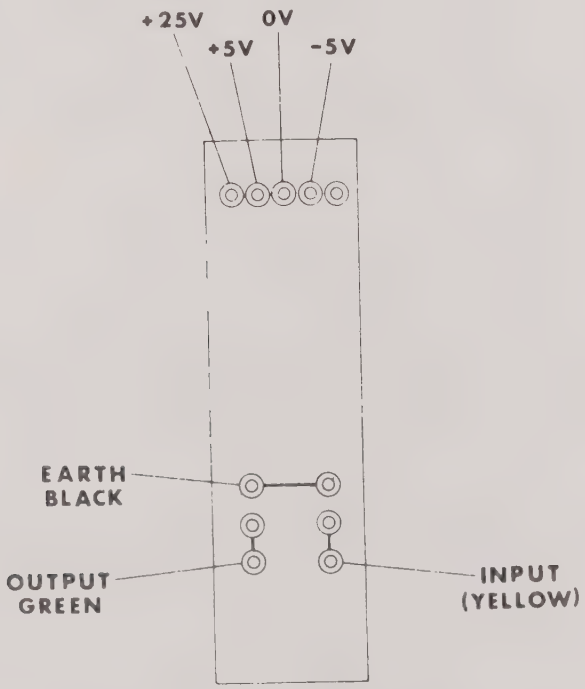
In the zero delay mode, the input signal feeds via R33 and gate VT9 to the pulse forming stage VT10 and VT11. The output trigger pulses from VT11 or VT13 are fed to the output socket via emitter follower VT14.

Should double pulse output be required, both VT8 and VT9 are switched on, enabling both the zero delay and the delayed trigger pulses to appear at the output.

The upper and lower values of delay are set on each range by trimmers T1 to T7 (lower limit) and P1 to P7 (upper limit).

The circuit operates from +5v, -5v and +25v provided by the power supply module PS/A. The supply currents are as follows:- +25V·· 20mA., +5V·· 35mA., -5V·· 27mA.

The output pulses are 4.5v in amplitude, rising from -0.5v to +4.0v.



| | | | | |
|---|---|---|---|---|
| R1 | Resistor | 1KΩ | 0.5 watt | 5% |
| R2 | " | 2.2KΩ | " | " |
| R3 | " | 470Ω | " | " |
| R4 | " | 1KΩ | " | " |
| R5 | " | 470Ω | " | " |
| R6 | " | 33KΩ | " | " |
| R7 | " | 470Ω | " | " |
| R8 | " | 47Ω | " | " |
| R9 | " | 470Ω | " | " |
| R10 | " | 10Ω | " | " |
| R11 | " | 470Ω | " | " |
| R12 | " | 3.3KΩ | " | " |
| R13 | " | 2.7KΩ | " | " |
| R14 | " | 100Ω | " | " |
| R15 | " | 220Ω | " | " |
| R17 | " | 3.3KΩ | " | " |
| R18 | " | 3.3KΩ | " | " |
| R19 | " | 470Ω | " | " |
| R20 | " | 1 KΩ | " | " |
| R21 | " | 2.2KΩ | " | " |
| R22 | " | 330Ω | " | " |
| R24 | " | 470Ω | " | " |
| R25 | " | 1 KΩ | " | " |
| R26 | " | 1 KΩ | " | " |
| R27 | " | 2.2KΩ | " | " |
| R28 | " | 680Ω | " | " |
| R29 | " | 470Ω | " | " |
| R30 | " | 1 KΩ | " | " |
| R31 | " | 100Ω | " | " |
| R32 | " | 2.7 KΩ | " | " |
| R33 | " | 100Ω | " | " |
| R34-R40 | " | 3.9KΩ | 0.25 watt | " |
| R41-R47 | " | 4.7KΩ | " | " |

| | | |
|---|---|---|
| P1 | Potentiometer | 5.6KΩ |
| P2 | " | 5.6KΩ |
| P3 | " | 5.6KΩ |
| P4 | " | 5.6KΩ |
| P5 | " | 5.6KΩ |
| P6 | " | 5.6KΩ |
| P7 | " | 5.6KΩ |
| P8 | " | 10KΩ Linear |
| T1 | " | 1 KΩ |
| T2 | " | 1KΩ |
| T3 | " | 1KΩ |
| T4 | " | 1KΩ |
| T5 | " | 1KΩ |
| T6 | " | 1KΩ |
| T7 | " | 1KΩ |

| | | | |
|---|---|---|---|
| L1 | Choke | 6.8μH | Painton |
| L2 | " | 6.8μH | " |
| L3 | " | 6.8μH | " |

| | | | | |
|---|---|---|---|---|
| C1 | Capacitor | 100pf | 20% | 400V |
| C2 | " | 1000pf | 5% | 400V |
| C3 | " | 0.01μF | 5% | 160V |
| C4 | " | 0.1μF | 5% | 160V |
| C5 | " | 1μF | 5% | 160V |
| C6 | " | 10μF | | 16V |
| C7 | " | 100μF | | 6.4V |
| C8 | " | 0.01μF | 5% | 160V |
| C9 | " | 22pf | 5% | 750V |
| C10 | " | 100μF | | 6.4V |
| C11 | " | 25μF | | 6.4V |
| C12 | " | 25μF | | 50V |

| | | | |
|---|---|---|---|
| VT1 | Transistor | TIS48 | T.I. |
| VT2 | " | TIS48 | T.I. |
| VT3 | " | BSX29 | SGS-F |
| VT4 | " | TIS48 | T.I. |
| VT5 | " | TIS48 | T.I. |
| VT6 | " | TIS48 | T.I. |
| VT8 | " | TIS48 | T.I. |
| VT9 | " | TIS48 | T.I. |
| VT10 | " | TIS48 | T.I. |
| VT11 | " | BSX29 | SGS-F |
| VT12 | " | TIS48 | T.I. |
| VT13 | " | BSX29 | SGS-F |
| VT14 | " | TIS48 | T.I. |
| VT15 | " | 2N3702 | T.I. |
| VT16 | " | BC212 | T.I. |

| | | | |
|---|---|---|---|
| D1 | Diode | 1N914 | T.I. |
| D2 | " | 1N914 | T.I. |
| D3 | " | 1N914 | T.I. |
| D4 | " | 1N914 | T.I. |
| D5 | " | 1N914 | T.I. |
| D6 | " | 1N914 | T.I. |
| D7 | " | 1N914 | T.I. |

Z1 Zener Diode ZF 5.6 I.T.T.

K1 Socket Coaxial 50Ω BNC

# WIDTH UNIT

PW / A

The pulse width module controls the duration of the output pulse available from the pulse generator.

The duration of the pulse can be varied from 0.1 μS to 1 S. in seven decade ranges.

| | | |
|---|---|---|
| 0.1 μ S. | - | 1 μ S. |
| 1 μ S. | - | 10 μ S. |
| 10 μ S. | - | 100 μ S. |
| 100 μ S. | - | 1 mS. |
| 1 mS. | - | 10 mS. |
| 10 mS. | - | 100 mS. |
| 100 mS. | - | 1 S. |

The output from the unit is a 4.5V negative going pulse (4.5V to 0V).

## CIRCUIT DESCRIPTION

The pulse width module is basically a conventional monostable multivibrator. Pulse width is varied by a seven position decade switch and fine intermediate control.

When driving the pulse width module via C1, directly from PF/A, the upper limit of frequency of operation is reduced to 5 MHz. Operating at a frequency of 10 MHz (i.e. a period of 100 nS.) with a pulse width set at 100nS, the output pulse is compressed to approximately 70 nS, allowing normal operation of the circuit.

The pulse width range is determined by switching into circuit one of the timing capacitors C1 to C7. The variable control on the front panel allows adjustment of pulse width over a decade range, and the circuit is designed such that the pulse width varies in a linear manner with control rotation.

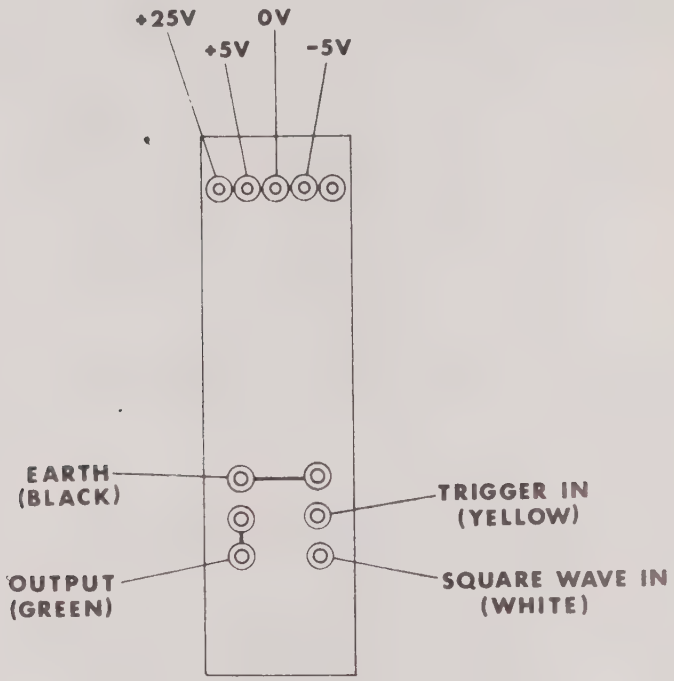
Transistors VT1 and VT4 form the multivibrator with the emitter follower transistor VT2 to increase the speed of switching. VT1 is normally in a cut-off state and is triggered on by the input pulse via diode D1. If the input pulse is from the p.r.f. generator, it is differentiated in the network C1 and R1, whilst trigger pulses from the delay unit are fed in via R17.

The timing current to the timing capacitor is fed via the constant current source VT3. RV1, the variable control, adjusts the current through VT3 to provide a variation in pulse width. The trimmer potentiometers T1 to T7 and P1 to P7 set the lower and upper limits on each range.

The positive pulse at the collector of VT4 is squared in the limiter stage formed by VT5 and VT6.

The circuit operates from + 5V, - 5V and + 25V lines provided by the power supply module PS/A.

The current from these lines is as follows:- +25V·· 60mA., +5V·· -15mA., -5V·· 22mA.


+25V
0V
+5V
-5V
EARTH
(BLACK)
TRIGGER IN
(YELLOW)
OUTPUT
(GREEN)
SQUARE WAVE IN
(WHITE)

| | | | | |
|---|---|---|---|---|
| R1 | Resistor | 2.2KΩ | 0.5 watt | 5% |
| R2 | " | 470Ω | " | " |
| R3 | " | 33KΩ | " | " |
| R4 | " | 470Ω | " | " |
| R5 | " | 10Ω | " | " |
| R6 | " | 3.3KΩ | " | " |
| R7 | " | 820Ω | " | " |
| R8 | " | 10Ω | " | " |
| R9 | " | 220Ω | " | " |
| R10 | " | 470Ω | " | " |
| R11 | " | 100Ω | " | " |
| R12 | " | 1KΩ | " | " |
| R13 | " | 470Ω | " | " |
| R14 | " | 120Ω | " | " |
| R16 | " | 330Ω | 1 watt | " |
| R17 | " | 100Ω | 0.5 watt | " |
| R18-24 | " | 3.9KΩ | 0.25 watt | " |
| R25-31 | " | 4.7KΩ | " | " |
| P1 | Potentiometer | 5.6KΩ | | |
| P2 | " | 5.6KΩ | | |
| P3 | " | 5.6KΩ | | |
| P4 | " | 5.6KΩ | | |
| P5 | " | 5.6KΩ | | |
| P6 | " | 5.6KΩ | | |
| P7 | " | 5.6KΩ | | |
| P8 | " | 10K Linear | | |
| T1 | " | 1 KΩ | | |
| T2 | " | 1 KΩ | | |
| T3 | " | 1 KΩ | | |
| T4 | " | 1 KΩ | | |
| T5 | " | 1 KΩ | | |
| T6 | " | 1 KΩ | | |
| T7 | " | 1 KΩ | | |

| | | | |
|---|---|---|---|
| C1 | Capacitor | 100pf 20% | 400V |
| C2 | " | 22pf 5% | 750V |
| C3 | " | 100μF | 6.4V |
| C4 | " | 10μF | 16V |
| C5 | " | 1μF 5% | 400V |
| C6 | " | 0.1μF 5% | 400V |
| C7 | " | 0.01μF 5% | 400V |
| C8 | " | 1000pf 5% | 400V |
| C9 | " | 100pf 20% | 400V |
| C10 | " | 25μF | 25V |
| C11 | " | 100μF | 6.4V |
| C12 | " | 25μF | 6.4V |
| VT1 | Transistor | TIS48 | T.I. |
| VT2 | " | TIS48 | T.I. |
| VT3 | " | 2N3702 | T.I. |
| VT4 | " | TIS48 | T.I. |
| VT5 | " | TIS48 | T.I. |
| VT6 | " | TIS48 | T.I. |
| VT8 | " | BC212 | T.I. |
| D1 | Diode | 1N914 | T.I. |
| D2 | " | 1N914 | T.I. |
| D3 | " | OA47 | Mullard |
| D4 | " | 1N914 | |
| Z1 | Zener Diode | ZF 5.6 | I.T.T. |

The output unit controls the output amplitude and polarity of the pulses from the pulse generating system.

The output pulse amplitude can be varied from 10V down to 30mV (into 50Ω) in stepped ranges of 10dB. A continuous level control enables the output amplitude to be varied between these steps.

The attenuator settings and output range are as listed:-

| | 50Ω | | | Open circuit | | |
|---|---|---|---|---|---|---|
| 0dB | 3V | - | 10V | 6V | - | 20V |
| 10dB | 1V | - | 3.3V | 2V | - | 6.6V |
| 20dB | 300mV | - | 1V | 600mV | - | 2V |
| 30dB | 100mV | - | 330mV | 200mV | - | 660mV |
| 40dB | 30mV | - | 100mV | 60mV | - | 200mV |

The output polarity is selected by the control switch, the pulses being referred to a base line of 0V.

The output impedance is 50Ω in order to reduce reflections arising from the fast rise times and is D.C. coupled into the load, giving low frequency pulses with no droop. Rise and fall times of pulses from this unit are less than 10nS.

## CIRCUIT DESCRIPTION

### Positive Pulses:

The input signal from the width unit (+4V to 0V) is routed via the pulse polarity switch to the base of emitter follower VT7. VT6 is not used in this mode. The signal from VT7 cuts off transistor VT9 for the duration of the input pulse and the inverted pulse at the collector is the required output waveform. The emitter of VT9 is switched to 0V and the collector load to the positive rail by the polarity switch.

The output amplitude is thus set by the level of the positive supply rail. This level can be varied by adjustment of potentiometer T1, the front panel amplitude control.

The pulse at VT9 collector is connected to the complementary emitter followers VT10 and VT11, VT12 and VT13 from which it passes to the output attenuator via the source resistor R6.

The output signal may be attenuated by the five position 40dB attenuator.

The output level control is calibrated into an open circuit and when feeding a 50Ω impedance, the output amplitude will be half the calibrated voltage.

Negative Pulses

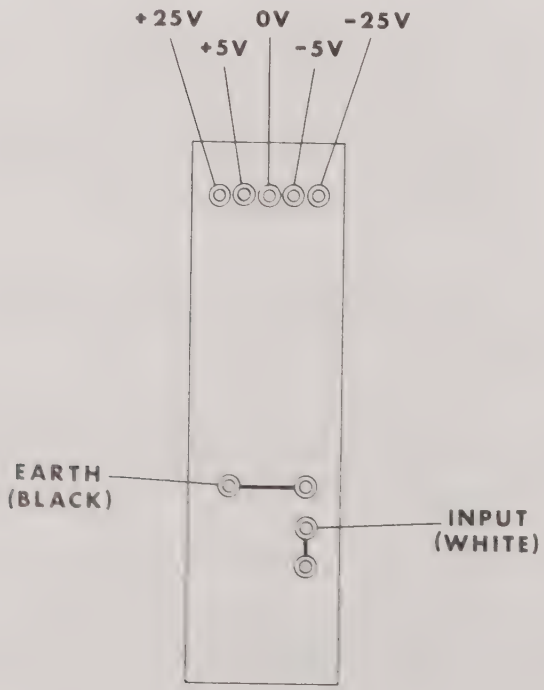
For negative output pulses, VT6 is switched into circuit and the input signal feeds the base of this stage. The waveform is now inverted prior to emitter follower VT7. The remainder of the circuit operates as previously. The negative and positive supply rails are switched to +5V and a varying negative potential set by T2 respectively. Transistors VT2 and VT3 are generously rated such that they are not over dissipated if the output is short circuited when the generator is operating with a high duty ratio. Negative going pulses are now available at the output.

Invert Pulses

Inverted pulses are obtained by switching SW3 to the output of the inverting stage VT3.

The unit will safely stand a short circuit across the output, but should be coupled via a capacitor if required to feed into a D.C. potential greater than 5V.

The module operates from +5V, -5V and -25V as supplied by the power supply module PS/A.



| | | | | |
|---|---|---|---|---|
| R1 | Resistor | 680Ω | 0.5 watt | 5% |
| R2 | " | 47Ω | " | " |
| R3 | " | 330Ω | " | " |
| R4 | " | 680Ω | " | " |
| R5 | " | 47Ω | " | " |
| R6 | " | 120Ω | " | " |
| R7 | " | 680Ω | " | " |
| R8 | " | 330Ω | " | " |
| R9 | " | 4.7KΩ | " | " |
| R10 | " | 330Ω | " | " |
| R11 | " | 220Ω | " | 2% |
| R12 | " | 330Ω | " | " |
| R13 | " | 330Ω | " | " |
| R14 | " | 4.7KΩ | " | " |
| R15 | " | 560Ω | 0.25 watt | " |
| R16 | " | 180Ω | 2 watt | " |
| R17 | " | 220Ω | 0.25 watt | " |
| R18 | " | 22Ω | 1 watt | " |
| R19 | " | 470Ω | 0.5 watt | " |
| R20 | " | 22Ω | 1 watt | " |
| R21 | " | 22Ω | " | " |
| R22 | " | 108Ω | 2 watt | 1% |
| R23 | " | 450Ω | 0.1 watt | " |
| R24 | " | 1530Ω | 0.5 watt | " |
| R25 | " | 4950Ω | " | " |
| R26 | " | 73Ω | " | " |
| R27 | " | 55.6Ω | " | " |
| R28 | " | 51.6Ω | " | " |
| R29 | " | 50.5Ω | " | " |

L1 Choke 0.9μH

Pla,b Potentiometer 5KΩ + 5KΩ Linear

| | | | | |
|---|---|---|---|---|
| C1 | Capacitor | 1,000pF | 50V | |
| C2 | " | 25μF | 50V | |
| C3 | " | 25μF | 50V | |
| C4 | " | 27pF | 20% | |
| C5 | " | 82pF | | |
| C6 | " | 82pF | | |
| C7 | " | 0.1μf | 20% | 160V |
| C8 | " | 0.1μF | 20% | 160V |
| C9 | " | 0.1μf | | 160V |
| C10 | " | 0.1μF | | 160V |
| C11 | " | 47pF | | |
| C12 | " | 0.1μF | 20% | 160V |
| C13 | " | 82pf | 10% | |

| | | | |
|---|---|---|---|
| VT1 | Transistor | 2N3053 | RCA |
| VT2 | " | 2N2218A | RCA |
| VT3 | " | TIS48 | T.I. |
| VT4 | " | BFX88 | Mullard |
| VT5 | " | 2N3055 | RCA |
| VT6 | " | BCY 71 | Mullard |
| VT7 | " | 2N2218A | T.I. |
| VT8 | " | 2N3053 | R.C.A. |
| VT9 | " | TIS48 | T.I. |
| VT10 | " | TIS48 | T.I. |
| VT11 | " | BCY71 | Mullard |
| VT12 | " | 2218A | T.I. |
| VT13 | " | BFX 88 | Mullard |

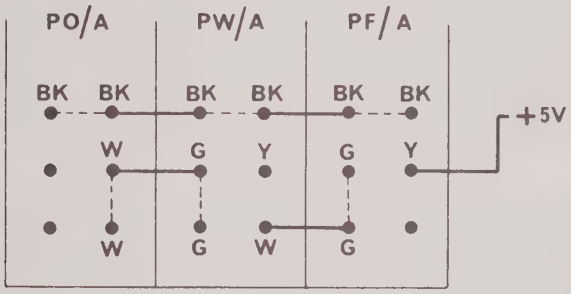
| | | | |
|---|---|---|---|
| D1 | Diode | 1N914 | T.I. |
| D3 | " | 1N914 | T.I. |
| D4 | " | 1N914 | T.I. |

# APPLICATIONS

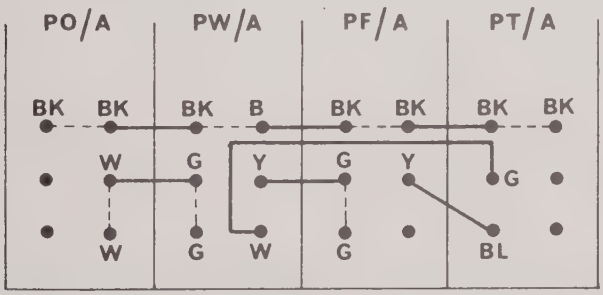
A variety of systems may be constructed from the range of modules which are currently available, and an even greater range of assemblies will be made possible by the introduction of further modules to cater for more specialised needs.

Typical arrangements are listed below:-

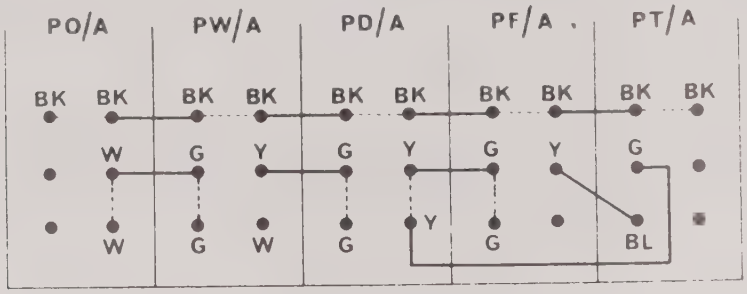
1. Pulse generator giving pulses of variable frequency, pulse width, output polarity and amplitude. The frequency of operation with this arrangement is restricted to an upper limit of 5 MHz.



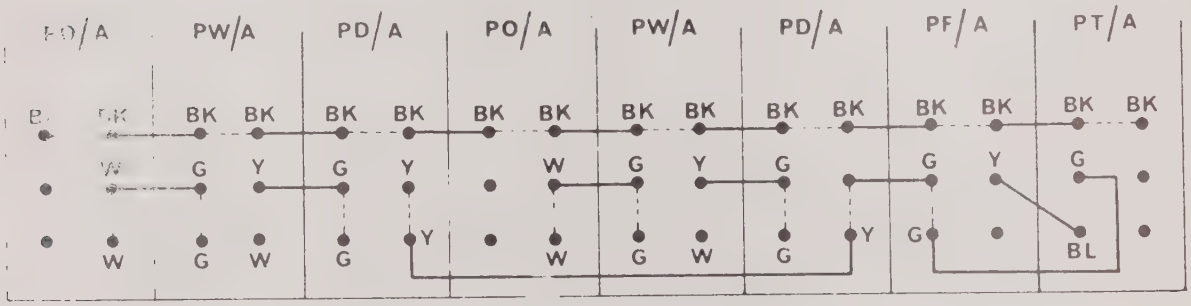

2. External trigger and pulse burst facility can be obtained by the inclusion of trigger unit PT/A. The frequency of operation with this arrangement is restricted to an upper limit of 5 MHz when operating on INTERNAL.



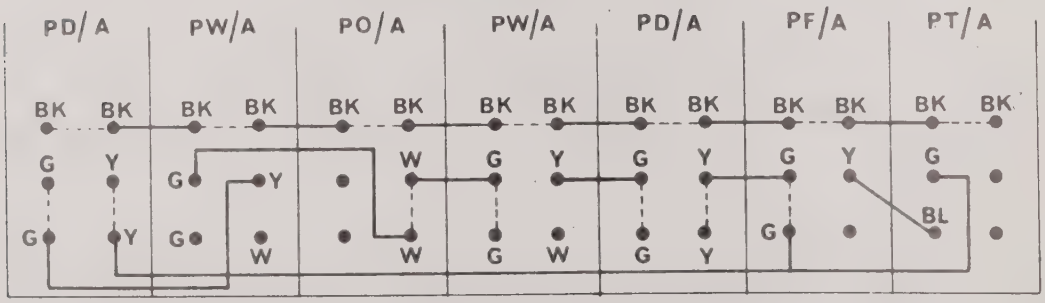
3. The Single Pulse Generating System, below provides the added facilities of variable delay, and paired pulse operation, and is assembled as shown.




4. The TRUE double pulse generator will produce double pulses, independent in delay, width, amplitude and polarity. The only common parameter is the initial trigger or the P.R.F. The modules incorporated in this system are as in the single pulse generator above with the duplication of delay, width and output units. The patching arrangement is as shown.




5. Should the requirement be for two pulses of independent delay and width, but in a serial form from a single output, a single output unit can be used, being fed by two pulse width units.



# OUTPUT UNIT VARIABLE SLOPE

PO/V

The variable slope output unit (PO/V) is an alternative output unit module to the standard output unit (PO/A) in the pulse generating system..

The unit offers the facility of being able to vary the rate of rise and fall times of the pulse, each being independently variable over a decade range, allowing a maximum ratio between rise and fall time of ten to one. The rate of rise and fall times of the pulse may be varied over seven switched decade ranges allowing the rate to be varied in the following ranges:-

1.1ns/v - 11ns/v or greater
11ns/v - 0.11µs/v or greater
0.11µs/v - 1.1µs/v or greater
1.1µs/v - 11µs/v or greater
11µs/v - 1.1ms/v or greater
1.1ms/v - 11ms/v or greater

The positive and negative excursions of the pulse are also independently variable through zero. The most positive level may be varied from +20V to -3V and the most negative may be varied from -20V to +3V. However it is necessary to incorporate a catching device to prevent inversion of the pulse when these controls are operated. The pulse amplitude may therefore be varied by these level controls over the range 4V to 40V peak to peak, into open circuit. A toggle switch may be operated to insert a 20dB (÷ 10) attenuator pad in series with the output. Note that this will also reduce the rate of rise and fall time, in terms of Volts/Second by a factor of 10.

An 'Invert' switch is also provided, although the action of this switch should be clearly understood, otherwise its effects can be a little confusing, especially when operating with long rise and fall times comparable with pulse width. On 'Normal' operation the beginning of the width pulse determines the point where the rising edge starts. At the termination of the set width pulse, the start of the falling edge is initiated. When operating in the 'Invert' mode, the beginning of the width pulse initiates the start of the falling edge, and the end of the width pulse initiates the start of the rising edge. In both cases the Rise and Fall controls control the rising and falling edges respectively.

The output impedance is 50Ω and the output is D.C. coupled.

## CIRCUIT DESCRIPTION

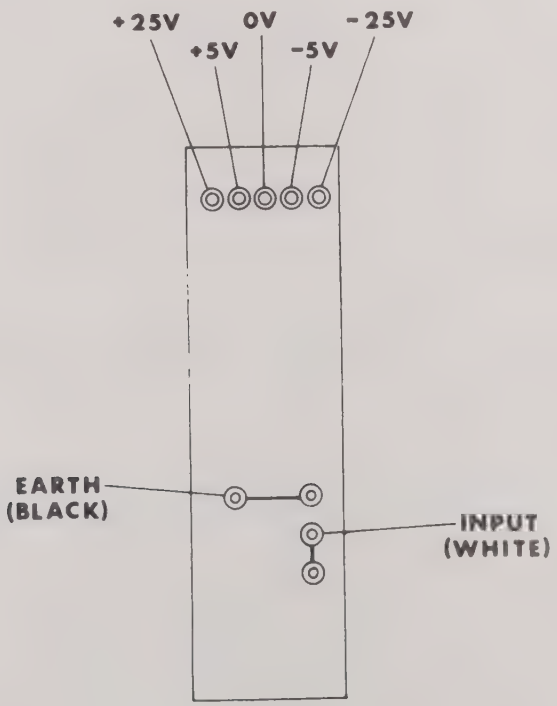
The circuit is fed from the width unit (PW/A) of the pulse generating system. The signal from the width unit, a negative-going pulse from +4V to 0v feeds into the transistor switch VT2, or via inverter VT1 into the transistor switch VT3. By applying +5V to the transistor bases the switch is closed, whilst 0V cuts the transistors off and opens the switch. The signal into VT4 may therefore be the input signal or its complement. VT4 and VT5 form a long tailed pair which switches the tail current into one or other of the collectors. When current flows in VT5 the voltage developed across the load turns on VT6 and turns off VT7. When VT6 is on, the collector voltage is emitter followed by VT8 such that the emitter VT9 is at a less positive voltage than the D.C. imposed on its base by emitter follower VT10.

The transistor is turned off therefore. However with VT7 turned off, emitter follower VT11 is turned off, hence VT12 acts as a constant current transistor, the current being determined by the voltage on its base, set by emitter follower VT13, and the variable resistor VR2. This current is used to discharge linearly the capacitor selected by the switch SW2. When the voltage becomes 1.5V less than the voltage set on the base of VT15, the transistor turns on and limits the negative excursion. When the input voltage causes VT5 to turn off, VT7 turns on, VT11 turns on and biases VT12 off. Also VT6 turns off, VT8 turns off, hence VT9 becomes a constant current transistor giving a current to charge the capacitor selected by switch SW2, linearly until transistor VT16 catches the positive excursion. Diode D4 prevents the catching levels from crossing each other.

Transistors VT16 and VT24 comprise what is effectively a complex multi-stage complementary emitter follower circuit which provides only current gain and no voltage gain.

The output impedance is set mainly by resistors R37, R43 and R44 in addition to the fundemental output impedance of the emitter followers. A 20dB attenuator pad may be switched on to allow an open circuit pulse amplitude of down to 0.4V.

The module operates from +25V, +5V, and -5V and -25V as supplied by the pulse generating system power supply module. Peak current requirements on the +25V and -25V lines are less than 300mA and do not occur simultaneously. Two such output modules may be operated from one power supply module.



# OUTPUT UNIT VARIABLE SLOPE

PO/V

| | | | | |
|---|---|---|---|---|
| R1 | Resistor | 1KΩ | 0.5W | 5% |
| R2 | " | 1KΩ | " | " |
| R3 | " | 1KΩ | " | " |
| R4 | " | 1KΩ | " | " |
| R5 | " | 1KΩ | " | " |
| R6 | " | 2.7KΩ | " | " |
| R7 | " | 2.2KΩ | " | " |
| R8 | " | 150Ω | " | " |
| R9 | " | 270Ω | " | " |
| R10 | " | 470Ω | " | " |
| R11 | " | 390Ω | " | " |
| R12 | " | 150Ω | " | " |
| R13 | " | 150Ω | " | " |
| R14 | " | 390Ω | " | " |
| R15 | " | 220Ω | " | " |
| R16 | " | 220Ω | " | " |
| R17 | " | 56Ω | " | " |
| R18 | " | 56Ω | " | " |
| R19 | " | 5.6KΩ | " | " |
| R20 | " | 5.6KΩ | " | " |
| R21 | " | 2.5KΩ | " | " |
| R22 | " | 25KΩ | " | " |
| R23 | " | 2.2KΩ | " | " |
| R24 | " | 2.2KΩ | " | " |
| R25 | " | 100Ω | " | " |
| R26 | " | 100Ω | " | " |
| R27 | " | 220Ω | " | " |
| R28 | " | 330Ω | " | " |
| R29 | " | 220Ω | " | " |
| R30 | " | 1.5KΩ | " | " |
| R31 | " | 560Ω | " | " |
| R32 | " | 47Ω | " | " |
| R33 | " | 10KΩ | " | " |
| R34 | " | 1KΩ | " | " |
| R35 | " | 68Ω | " | " |
| R36 | " | 47Ω | " | " |
| R37 | " | 22Ω | 1W | " |
| R38 | " | 15KΩ | 0.5W | " |
| R39 | " | 10KΩ | " | " |
| R40 | " | 1KΩ | " | " |
| R41 | " | 68Ω | " | " |
| R42 | " | 47Ω | " | " |
| R43 | " | 22Ω | 1W | " |
| R44 | " | 47Ω | " | " |
| R45 | " | 62Ω | " | " |
| R46 | " | 250Ω | 0.5W | " |
| R47 | " | 62Ω | 1W | " |
| R48 | " | 68Ω | 0.5W | " |
| R49 | " | 1KΩ | " | " |

| | | | |
|---|---|---|---|
| C1 | Capacitor | 50μF | 25V |
| C2 | " | 50μF | 25V |
| C3 | " | 20μF | 6V |
| C4 | " | 20μF | 6V |
| C5 | " | 0.01μF | 160V |
| C6 | " | 47pF | 400V |
| C7 | " | 100pF | 400V |
| C8 | " | 100pF | 400V |
| C9 | " | 0.01μF | 160V |
| C10 | " | 0.01μF | 160V |
| C11 | " | 0.01μF | 160V |
| C12 | " | 0.01μF | 160V |
| C13 | " | 0.01μF | 160V |
| C14 | " | 0.01μF | 160V |
| C15 | " | 0.01μF | 160V |
| C16 | " | 0.01μF | 160V |
| C17 | " | 0.01μF | 30V |
| C18 | " | 0.01μF | 160V |
| C19 | " | 0.01μF | 30V |
| C20 | " | 0.01μF | 30V |
| C21 | " | - | - |
| C22 | " | 330pF | 400V |
| C23 | " | 3,300pF | 400V |
| C24 | " | 0.033μF | 160V |
| C25 | " | 0.33μF | 160V |
| C26 | " | 3.3μF | 63V |
| C27 | " | 32μF | 64V |
| C28 | " | 32μF | 64V |
| C29 | " | 0.1μF | 30V |
| C30 | " | 82pF | 500V |
| C31 | " | 4.7pF | 500V |
| C32 | " | 4.7pF | 500V |
| C33 | " | 0.1μF | 30V |
| C34 | " | 82pF | |

| | | |
|---|---|---|
| VT1 Transistor | TIS48 | T.I. |
| VT2 " | TIS48 | T.I. |
| VT3 " | TIS48 | T.I. |
| VT4 " | TISS0 | T.I. |
| VT5 " | TISS0 | T.I. |
| VT6 " | TIS48 | T.I. |
| VT7 " | BCY 71 | Mullard |
| VT8 " | 2N2904 | Motorola |
| VT9 " | 2N2904 | Motorola |
| VT10 " | BC182L | T1 |
| VT11 " | 2N2218A | SGS |
| VT12 " | 2N2218A | SGS |
| VT13 " | 2N3702 | T1 |
| VT14 " | BFX 88 | Mullard |
| VT15 " | 2N3053 | R.C.A. |
| VT16 " | BC 182L | T1 |
| VT17 " | BCY71 | Mullard |
| VT18 " | BC182L | T1 |
| VT19 " | 2N2218A | SGS |
| VT20 " | 2N2218A | SGS |
| VT21 " | 2N2902 | Motorola |
| VT22 " | BFX 88 | Mullard |
| VT23 " | 2N2904 | Motorola |
| VT24 " | 2N2218A | SGS |

| | | |
|---|---|---|
| D1 Diode | 1N914 | T1 |
| D2 " | 1N914 | T1 |
| D3 " | 1N914 | T1 |
| D4 " | 1N914 | T1 |
| D5 " | 1N914 | T1 |
| D6 " | 1N914 | T1 |
| D7 " | 1N914 | T1 |
| D8 " | 1N914 | T1 |
| D9 " | 1N914 | T1 |
| D10 " | 1N914 | T1 |

| | |
|---|---|
| P1 Potentiometer | 1KΩ Linear |
| P2 " | 1KΩ Linear |
| P3 " | 1KΩ Linear |
| P4 " | 1KΩ Linear |

| | | | | |
|---|---|---|---|---|
| ZD1 Zener Diode | BZY 88 | C27 | 5% | Mullard |
| ZD2 " | BZY 88 | C27 | 5% | Mullard |

# PULSE FREQUENCY DIVIDER

PF/D

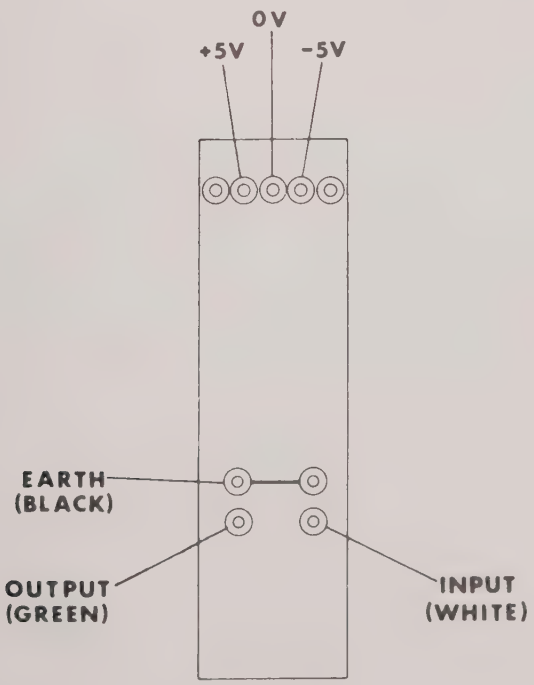
The PF/D module when operated in conjunction with the PF/A, P.R.F. generator module may be used to widen the pulse repitition frequency range down to 0.01Hz. The PF/D accepts pulses from the PF/A module and may be set to divide the P.R.F. by one, ten, or one hundred. The output from this unit may be used to drive the Pulse Delay Unit, PD/A, or the Pulse Width Unit PW/A. The output from the PF/D unit is in the form of short pulses +4V in amplitude.

The PF/D unit should not be used on the X0.1 and X0.01 ranges for input frequencies greater than 1MHz.

## Circuit Description

The squa e wave input from the PF/A unit is attenuated by resistors R1 and R2 and then fed to the RTL decade divider integrated circuit IC 1. The output from this is fed to the second decade divider integrator circuit IC 2. The outputs from these two integrated circuits as well as the unattenuated input are fed to the emitter follower transistors VT2, VT3 and VT4, one to each transistor. One of the outputs from these transistors is selected by one of the three transistor gates: VT5, VT6, and VT7. These gates are turned on by connecting the bases to the 0V line and turned off by returning the bases via R13 to the +5V line. The range switch turns on the gate appropriate to the range selected. The output from these gates is developed across the common load R10. This output is fed to VT8 which has an inductive load resulting in negative going spikes at the output for positive edges at the base and vice versa. Transistor VT9 is an emitter follower which gives a low impedance output and which is increased to be nominally 50Ω by R19. Diode D1 removes the negative going spikes leaving only the required short positive pulses at the output.

The unit operates from +5V and -5V provided by the power supply module PS/A.



| | | | | |
|---|---|---|---|---|
| R1 | Resistor | 3.9KΩ | 0.5 Watts | 5% |
| R2 | " | 3.9KΩ | " | " |
| R3 | " | 1KΩ | " | " |
| R4 | " | 470Ω | " | " |
| R5 | " | 68Ω | " | " |
| R6 | " | 470Ω | " | " |
| R7 | " | 220Ω | " | " |
| R8 | " | 220Ω | " | " |
| R9 | " | 220Ω | " | " |
| R10 | " | 1KΩ | " | " |
| R11 | " | 220Ω | " | " |
| R12 | " | 220Ω | " | " |
| R13 | " | 10KΩ | " | " |
| R14 | " | 150Ω | " | " |
| R15 | " | 1.2KΩ | " | " |
| R16 | " | 8.2KΩ | " | " |
| R17 | " | 1.2KΩ | " | " |
| R18 | " | 1KΩ | " | " |
| R19 | " | 47Ω | " | " |

| | | | |
|---|---|---|---|
| C1 | Capacitor | 0.22μF | 400V |
| C2 | " | 0.22μF | 400V |
| C3 | " | 0.1μF | 160V |
| C4 | " | 8μF | 25V |
| C5 | " | 0.1μF | 160V |
| C6 | " | 1000pF | 400V |

| | | | |
|---|---|---|---|
| D1 | Diode | IN659 | T1 |

| | | | |
|---|---|---|---|
| VT1 | Transistor | 2N3053 | RCA |
| VT2 | " | BC212L | T1 |
| VT3 | " | BC212L | T1 |
| VT4 | " | BC212L | T1 |
| VT5 | " | BC212L | T1 |
| VT6 | " | BC212L | T1 |
| VT7 | " | BC212L | T1 |
| VT8 | " | TIS48 | T1 |
| VT9 | " | TIS48 | T1 |

| | | | | |
|---|---|---|---|---|
| IC 1 | Integrated Circuit | | MC780P6909 | Motorola |
| IC 2 | " | " | MC780P6909 | Motorola |

| | | | | |
|---|---|---|---|---|
| L1 | Choke | 6.8μH | Painton | 0010 |

# COUNTED PULSE GATE

PG/A

The PG/A module is normally fitted adjacent to the PF/A module in place of a trigger module PT/A since it will provide most of the facilities offered by this module.

It may be used to gate a preset number of pulses from 1 to 999,999 as set on six front panel thumbwheel switches. Alternatively, by sliding the switch over on the rear panel, it may be used to divide the PF/A frequency by 1 to 999,999.

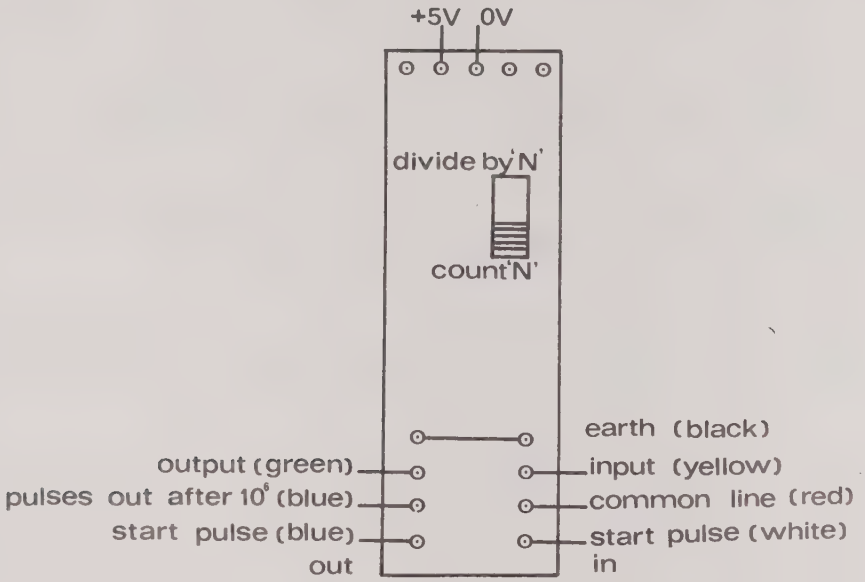
When used to provide counted pulse trains, the train is initiated by depressing a push-button switch on the front panel or by a positive start pulse to either of the two input sockets - one on the front panel and one on the rear panel.

After a start pulse is given, the module will wait until the next complete pulse arrives from the PF/A module before commencing the count. In a complex logic circuit, the PF/A may feed another output unit to provide a synchronous clock source. Once a start pulse is received, further start pulses are inhibited until the pulses have been gated. A lamp on the front panel indicates when the module has been triggered. Depressing the reset button during the gating period will cause the pulse train to be truncated, although after the count the unit resets itself. If P.R.F. pulses are required continuously select 'NORMAL' on the front panel toggle switch. For gated trains or in the divide by N mode select 'COUNT'.

The output of the PG/A module is suitable for driving the pulse delay or pulse width modules.

## CIRCUIT DESCRIPTION

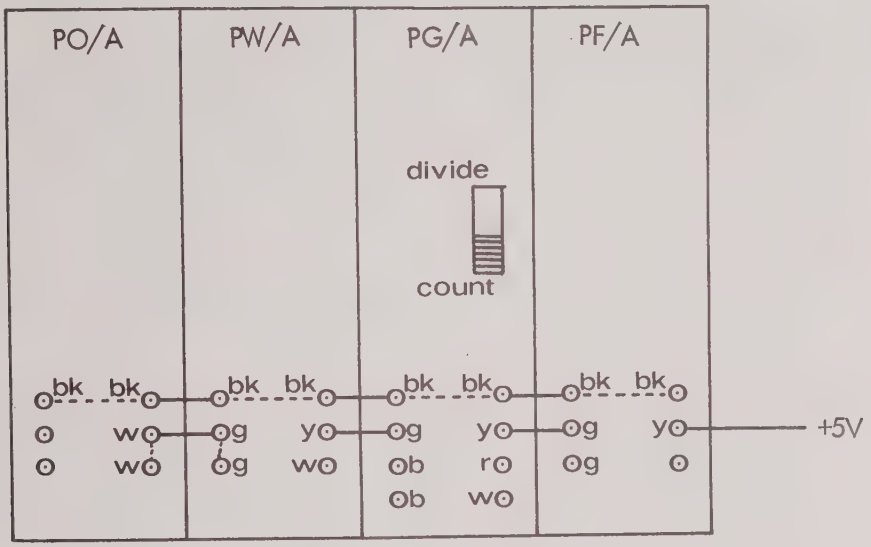
A start pulse is shaped by the monostable IC15 and gated through to a nor latch if the unit is not already counting. The nor latch stores this start pulse until the output from the PF/A module goes low. When this occurs the nand latch is set which inhibits further start signals, resets the nor latch, removes the reset from the SN7490 decade counters and allows the train of pulses out. When the number of pulses counted by the SN7490 s equals the number preset on the thumbwheel switches, the common diode line goes low and resets the nand latch, resetting the SN7490 counters and inhibiting the output pulses.



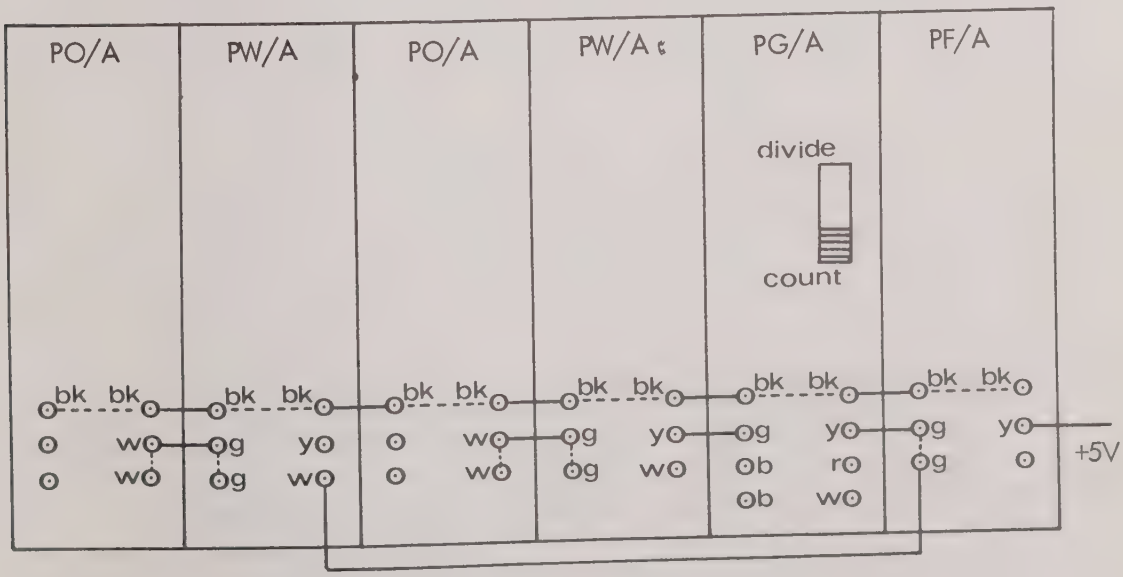

| | |
|---|---|
| MAXIMUM P.R.F. | 10 MHz |
| MAXIMUM TRIGGERING RATE | 5 MHz |
| MINIMUM TRIGGER LEVEL | 2.4V pk |
| MAXIMUM TRIGGER LEVEL | 5.0V pk |
| MAXIMUM TRIGGER TRANSITION TIME for reliable triggering | 1V/sec |
| MAXIMUM DURATION OF TRIGGER PULSE | 50nSec |

Note: When using this module in a double pulse generator system it is necessary to replace the +5V fuse in the power supply module with one rated at 1A.

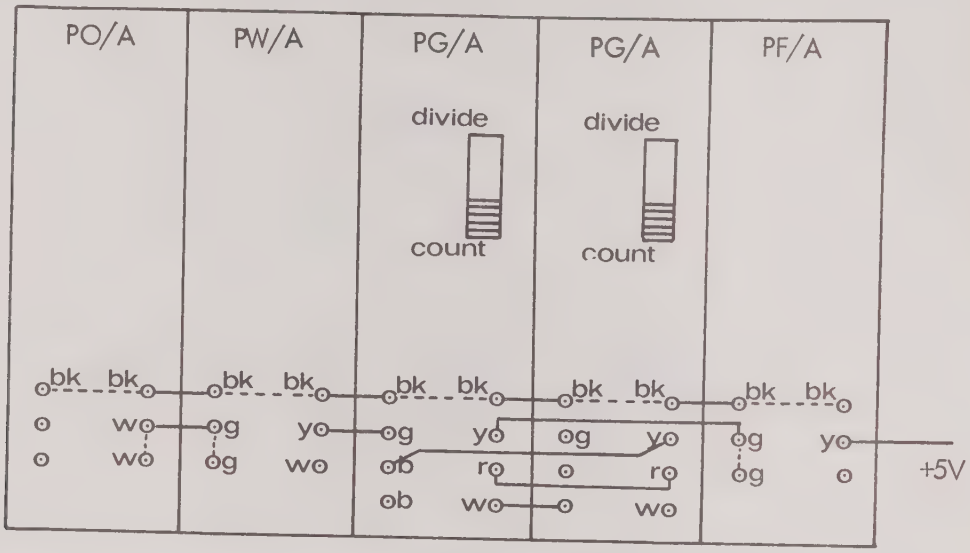
1. Replacing the trigger unit with the PG/A module.
With the PG/A module set to count one pulse, it can be used to give a single shot.




2. Connection in a double pulse generator system allows gated pulses in one channel and continous pulses, for use as a clock for example, in the other channel.

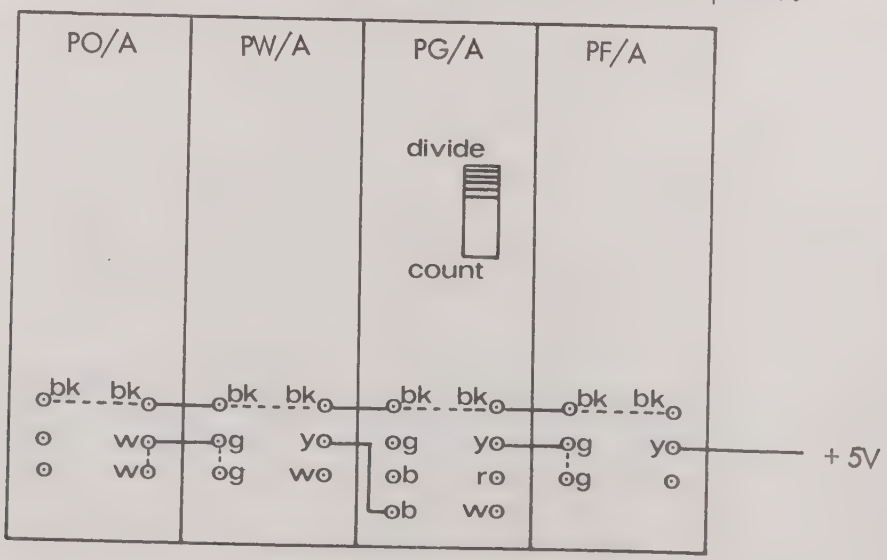


3. Two PG/A units may be cascaded to provide trains of up to $10^{12} - 1$ pulses. In this example the PG/A module nearest the PF/A is used to set up the most significant figures and is also where the start pulse is operated from. Resetting either module will cause the system to reset.




Cascading may only be used with a single PO/A system because of power consumption limitations.

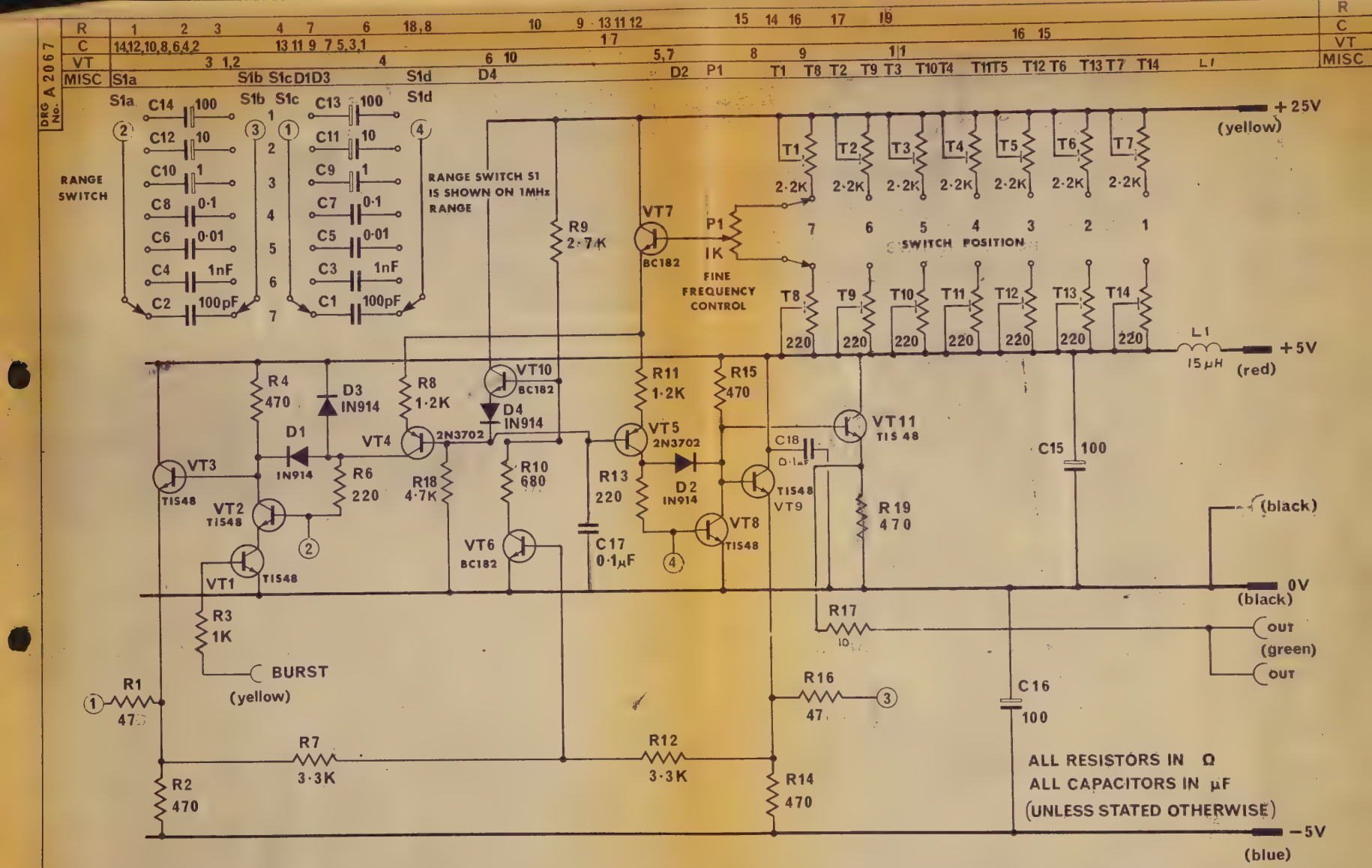
4. Connections for using the PG/A module as a presettable divide by N counter where N is the number set up on the thumbwheel switches.
Note:- If alterations are made to the preset number it may be necessary, if the PG/A stops dividing, to press the start button to initiate the sequence.



DRG No. B2091

| | | |

| | | |




| ISS. | DATE | MOD No. | | | |
|---|---|---|---|---|---|
| 5 | 23·6·70 | 767 | 6 | 31·12·70 | 839 |
| 4 | 25·11·69 | 672 | 7 | 1·7·71 | Q 943 |
| 3 | 10·1·69 | 544 | 8 | 7·8·73 | Q 2367 |
| 2 | 21·1·69 | 518 | 9 | 25·4·74 | Q 2836 Q 2850 |
| 1 | 10·4·68 | | | | |

TRACED

CHECKED

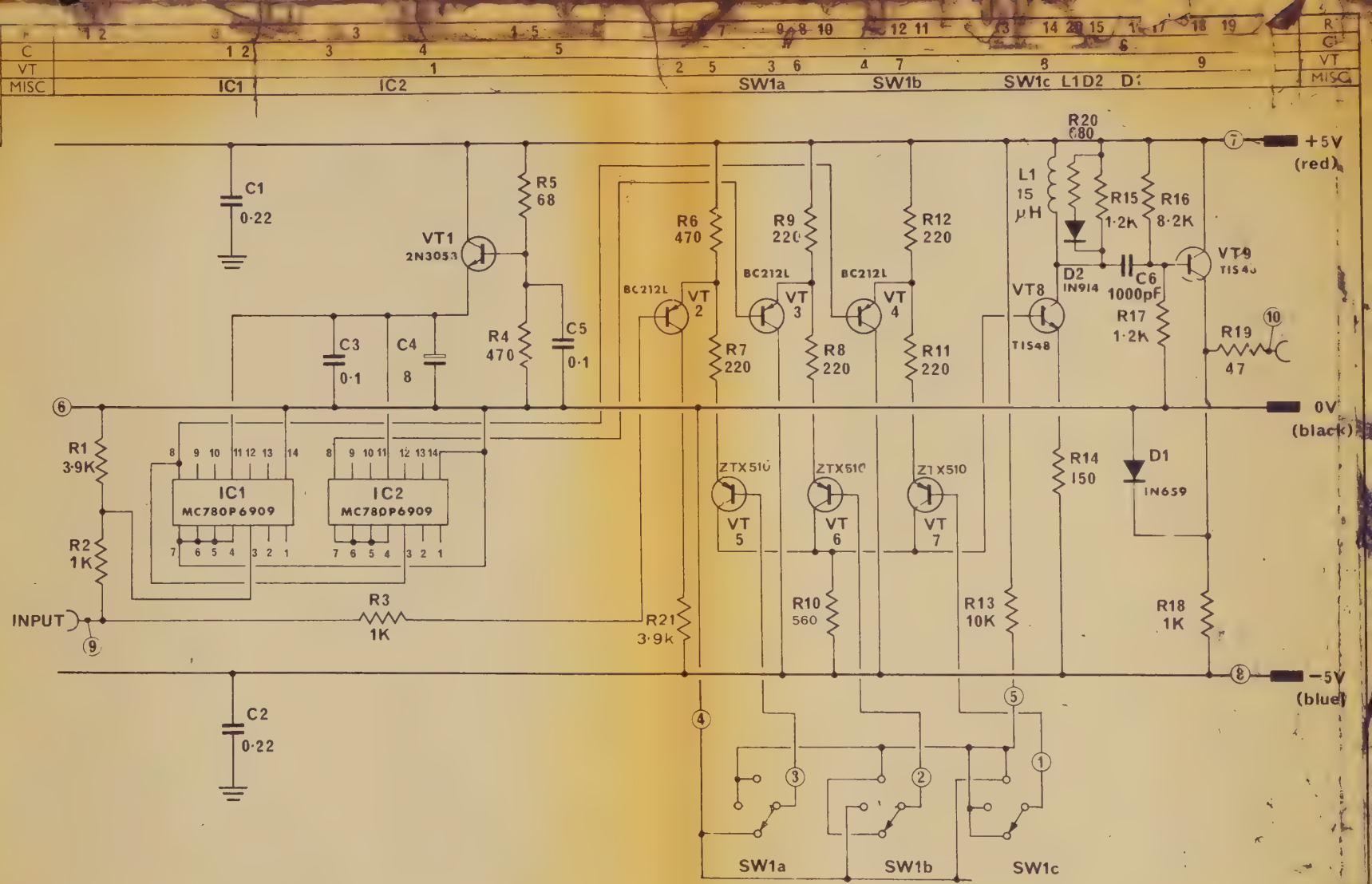
DRAWN DW.

FARNELL INSTRUMENTS LTD, WETHERBY, YORKS.

CIRCUIT DIAGRAM

PULSE GENERATOR P.R.F. GENERATOR

DRAWING No. A2067

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| TRACED | | 4 | 19 9 77 | Q4373 | |
| CHECKED | | 3 | 12-10-72 | Q1[illegible] | |
| DRAWN | D.W. | 2 | 20·7·71 | 938 | |
| | | ISS. | DATE | MOD No | |
| | | 1 | 19-6-69 | | |

NOTE —
CAPACITOR VALUES GIVEN IN µF
RESISTOR VALUES IN Ω
(2) REFERS TO CCT BD PIN CONNECTION Nos

FARNELL INSTRUMENTS LTD. WETHERBY, YORKS.

CIRCUIT DIAGRAM

PULSE GENERATOR DIVIDER UNIT

DRAWING No SHT 1 OF 1 SHTS
3-3424.

VT1, 2, 4, 5, 6, 8, 10, 12, 14. - TIS48
VT3, 11, 13. - BSX29
VT16 - BC212
VT15 - 2N3706.

R13 2.7K
R14 100
RV1 10K MULTIPLIER
VT15
S1A
T1 1K
T2 1K
T3 1K
T4 1K
T5 1K
T6 1K
T7 1K
R42 560
S1b
R26 1K
VT16
Z1 ZF5.6
R15 220
P1
P2
P3
P4
P5
P6
P7
R34 3.9K
R35 3.9K
R36 3.9K
R37 3.9K
R38 3.9K
R39 3.9K
R40 3.9K
C12 32
YELLOW
R2 2.2K
L1 6.8
R33 100
R1 1K
VT1
VT2
R3 470
R5 470
R13 470
D2
VT4
R8 50
VT5
R7 470
C1 100pF
C7 100 25V
C6 10
R10 10
VT6
R11 470
R4 1K
R6 33K
R9 470
C8 0.01
+VE SYNC. OUT
SWITCH POSITION
C4 0.1
C3 0.01
C2 1K
R12 3.3K
C9 22pF
R21 2.2K
D4
L2 6.8
VT11
VT9
VT8
R18 3.3K
R20 1K
R17 3.3K
VT10
R25 1K
R22 330
R24 470
R27 2.2K
D5
L3 5.8
VT12
VT13
D6
D7
R28 470
R29 470
2.7K
VT14
R49 12
L4 15
RED
+5V
C10 100
BLACK
0V
BLACK
C11
R31 100
R30 1K
GREEN
GREEN
S2A
S2B
MODE SWITCH.

RANGE SWITCH S1, IS SHOWN ON 1SEC RANGE.

| ISSUE | DATE | MOD. No. |
|---|---|---|
| 12 | 10·1·72 | Q 1240 |
| 11 | 13·9·71 | Q 1053 |
| 10 | 17·8·71 | Q 1001 |
| 9 | 31·12·70 | 839 |

NOTE: ALL RESISTORS IN OHMS.
ALL CAPACITORS IN MICROFARADS.
UNLESS OTHERWISE STATED

FARNELL INSTRUMENTS LTD. WETHERBY, YORKS.

TITLE: CIRCUIT DIAGRAM.

DRAWING No. -20

| | | |

| | | |

2-3432

| | | |

| DRAWING No. | | |

MP MASTER
MA23431